AIST & ESIP
New Observing Strategies (NOS)

# StereoBit: Advanced Onboard Science Data Processing to Enable Future Earth Science

ESTO Earth Science Technology Office

**PI: James Carr**

Dr. Carr is a member of the TEMPO science team and a frequent collaborator with Code 600 and NOAA STAR in the area of atmospheric research. His training is in physics and he has played a lead role in weather satellite programs in the U.S. and internationally, including GOES-R and Meteosat.

**Co-I: Chris Wilson (GSFC Institutional PI)**

Dr. Wilson is an early-career computer engineering researcher in Code 587 specializing in high-performance and reconfigurable computing for space applications. Chris will lead the efforts of Code 587 in the execution of the AIST effort.

**Co-I: Dong Wu**

Dr. Wu is an atmospheric scientist with broad experience including MISR, CMIS (as Co-I), SORCE/TSIS, and microwave remote sensing. He is a collaborator with Dr. Carr on stereo 3D winds and author on several paper on the subject. Dong will provide scientific guidance for our AIST effort.

**Co-I: Matthew French**

Matthew French is a former 2x AIST PI. He provides continuity to earlier research efforts with SpaceCube hardware and is our lead SME for the Virtual Constellation Engine (VCE) and a High-Level Synthesis (HLS) SME.

**Collaborator: Michael Kelly**

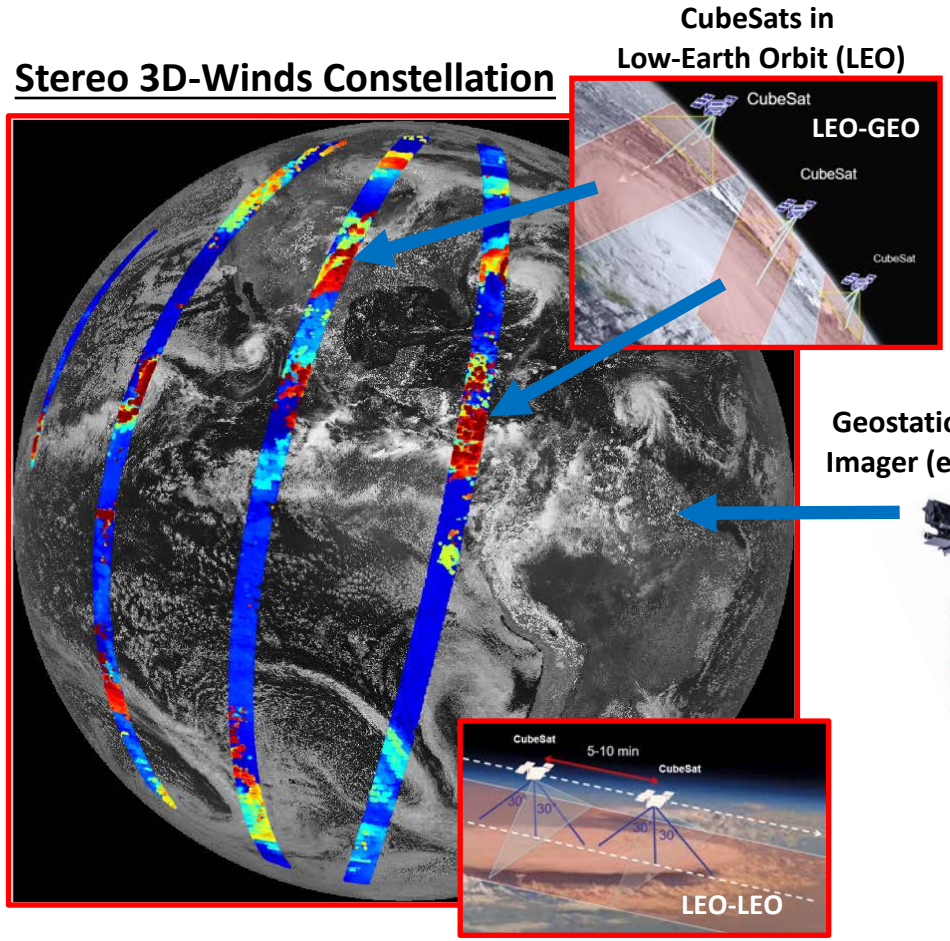
Dr. Kelly is the CMIS PI and a collaborator with Dr. Wu and Dr. Carr on the development of stereo 3D-wind methods and mission concepts. The CMIS instrument is the model application for the application development to be pursued under this AIST award.

# StereoBit Project Vision/Objectives

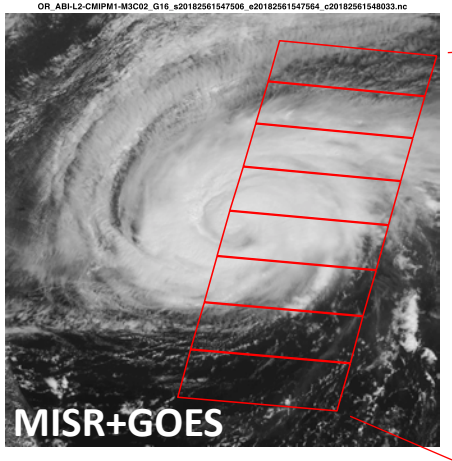


***Advance Onboard Science Data Processing Capabilities within CubeSat Size Weight and Power: Develop a Specific Application for SpaceCube tied to High-Priority Decadal Survey Science***

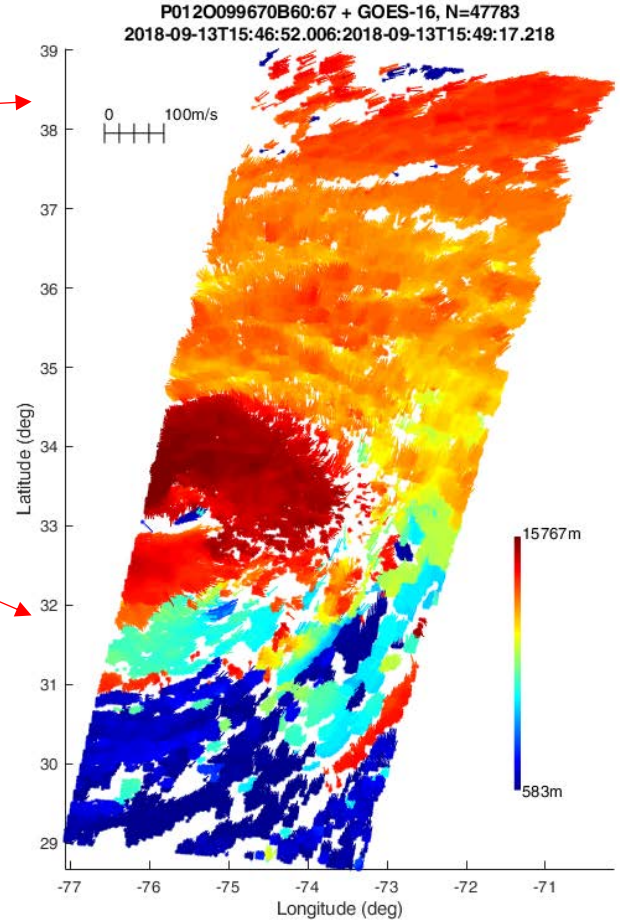
**Stereo 3D-Winds Constellation**




**Leader-Follower Configuration works over the Poles too**




**Hurricane Florence**



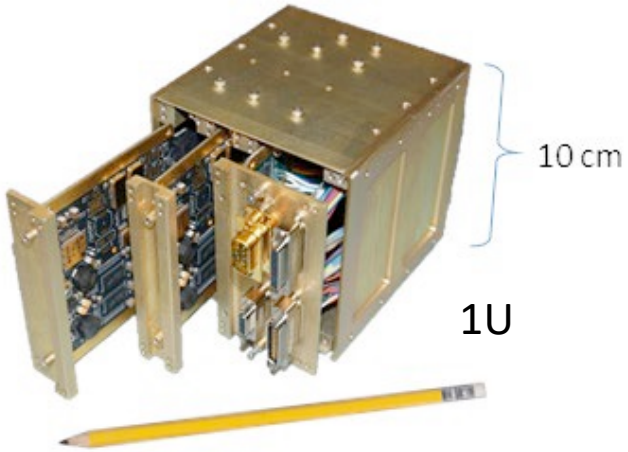

**Stereo 3D-Winds Product**

- Vertically resolve winds using **Structure from Motion (SfM) stereo tracking** of clouds
- **Integrate operations** between platforms
- Disaggregate science processing to **alleviate downlink bottleneck** of constellation architectures
- **Infuse knowledge** into the Earth Science community from our experience developing a science application on SpaceCube

# Project Technologies

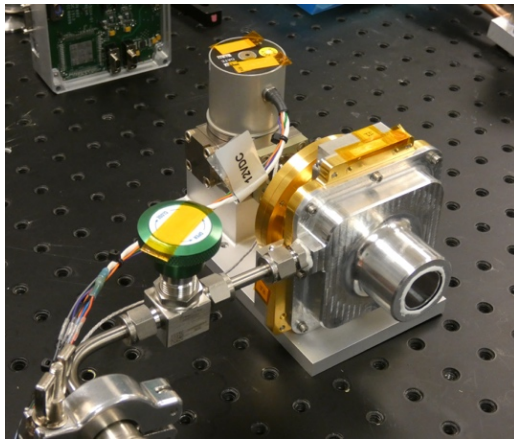


## SpaceCube Processor




- CPU and Reconfigurable Field Programmable Gate Arrays (FPGAs)
- Mini/Mini-Z: fits within CubeSat Resource Limits
- ESTO Funded

## Compact Midwave IR Sensor (CMIS)

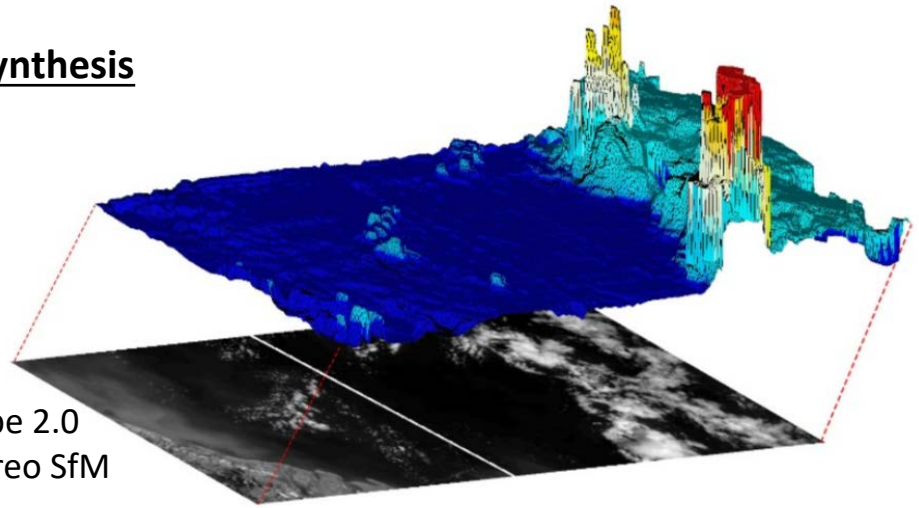


- Target for our science application
- Multi-angle push-broom with fore, nadir, aft views like MISR
- Type-2 Super Lattice (T2SL) detector
- ESTO Instrument Incubator Program

| Field | Number |
|---|---|
| Multi-Spectral | 2.25, 3.75, 4.05 µm |
| Multi-Angle | Fore, Nadir, Aft views at 3.75 µm |
| Weight, Power | 3 kg, 7 W |
| Operating Temperature | 150 K |

## Software & Synthesis

- NASA core Flight System (cFS)/core Flight Executive (cFE)
- Tools to synthesize FPGA logic from C/Python
- Virtual Constellation Engine (VCE) from AIST-16



SpaceCube 2.0
IR&D Stereo SfM

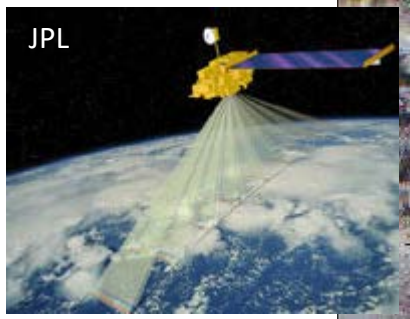
# "Fly" StereoBit at GSFC



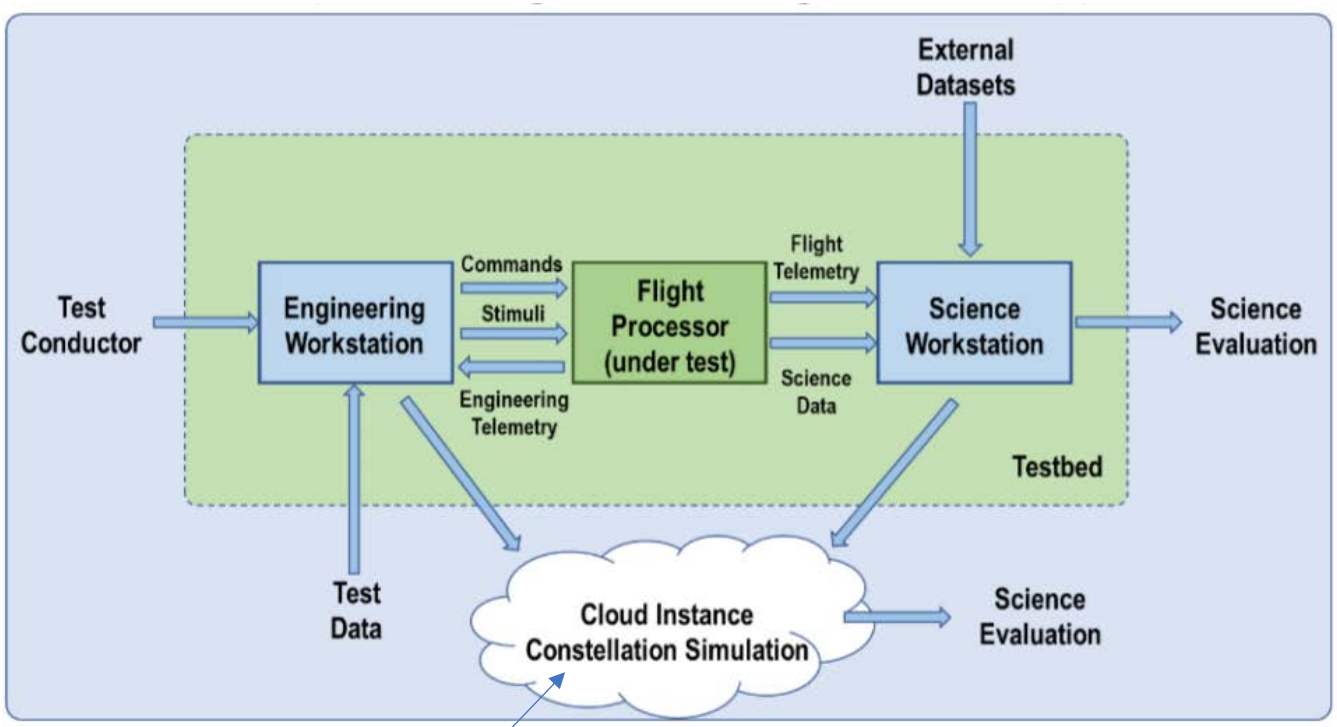
- **Demonstration of a nearly Flight-Ready Application**
- **Best Practices for Science Application Development on SpaceCube**

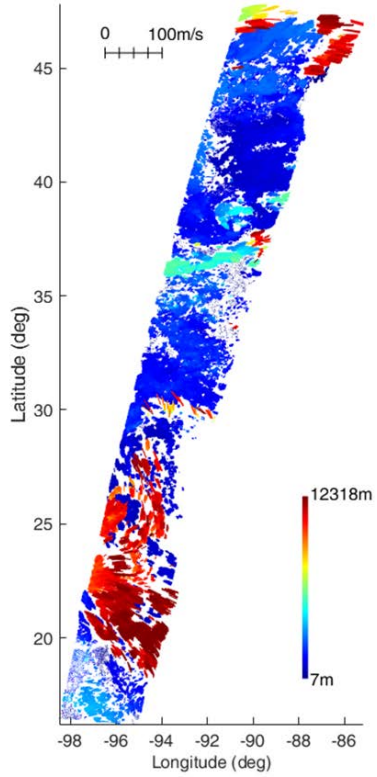
**Direction of Flight**

**Proxy Data Simulated from MISR**




**+ Simulated GPS & Star Trackers**




**Simulation of LEO-LEO Leader-Follower Configuration**